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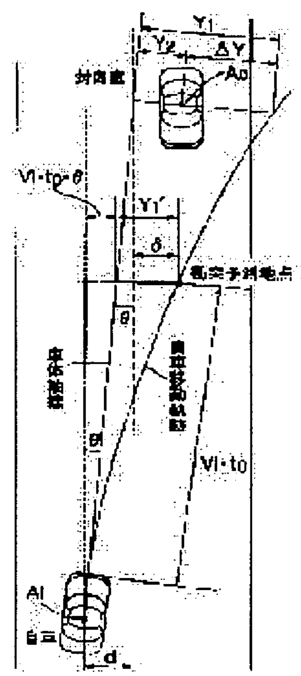
(54) RUNNING SAFETY DEVICE FOR VEHICLE

(57)Abstract:
PROBLEM TO BE SOLVED: To prevent the execution of unnecessary clash avoidance control by accurately deciding the possibility of a clash with an oncoming vehicle.
SOLUTION: A lateral movement amount Y1 when an own car Ai is advanced to a present oncoming vehicle Ao based on the car speed Vi and the yaw rate ri of the own car Ai, is calculated and based on a relative distance, a relative speed, and a relative angle between the own Ai and the oncoming car Ao, detected by a radar information processing device, a relative lateral distance Y2 of the oncoming car Ao to the car body axis of the own car Ai is calculated. When a relative lateral deviation ΔY obtained by deducting the lateral movement amount Y1 from the relative lateral distance Y2 is in a range of −ε·ΔY·ε and the state is continued for a time exceeding a given time Ts, it is decided that there is the possibility of the own car Ai clashing with the oncoming car Ao and automatic steering is executed to prevent the occurrence of a clash.



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CLAIMS

[Claim(s)]

[Claim 1] A body detection means to detect the body which exists in the travelling direction of a self-vehicle (Ai) (4), A migration locus presumption means to presume the future migration locus of a self-vehicle (Ai) (M1), A relative horizontal deflection calculation means to compute the relative horizontal deflection (deltaY) of a self-vehicle (Ai) and an oncoming car (Ao) based on the future migration locus of the detection result by the body detection means (4), and said self-vehicle (Ai) (M2), A contact possibility judging means to judge with there being possibility that a self-vehicle (Ai) and an oncoming car (Ao) will contact when the condition that the relative horizontal deflection (deltaY) computed with the relative horizontal deflection calculation means (M2) is in the predetermined range (- epsilon-epsilon) passes beyond predetermined time (Ts) (M3), The transit safety device of the car characterized by having a contact evasion means (M4) to perform contact evasion steering when a contact possibility judging means (M3) judges with there being possibility that a self-vehicle (Ai) and an oncoming car (Ao) will contact.

[Claim 2] It comes to have an amount calculation means of rain deviation (M5) to compute the amount (delta) of deviation from a self-vehicle transit lane to the oncoming car transit lane of the self-vehicle (Ai) in the time of a self-vehicle (Ai) meeting with an oncoming car (Ao). It is the transit safety device of a car according to claim 1 characterized by judging with a contact possibility judging means (M3) having possibility that a self-vehicle (Ai) and an oncoming car (Ao) will contact when the amount (delta) of deviation computed with the amount calculation means of rain deviation (M5) is beyond a predetermined threshold (delta 0).

[Claim 3] Said predetermined time (Ts) is a transit safety device of a car according to claim 1 or 2 characterized by being set up so short that the relative velocity (deltaV) of a self-vehicle (Ai) and an oncoming car (Ao) being so large that the relative distance (deltaL) of a self-vehicle (Ai) and an oncoming car (Ao) being small.

[Claim 4] A contact evasion means (M4) is the transit safety device of a car given in any of claims 1-3 which are characterized by starting contact evasion steering when time amount (t0) until a self-vehicle (Ai) meets with an oncoming car (Ao) becomes below a predetermined threshold (tau 0) they are.

[Claim 5] The amount of target evasion (S) by the contact evasion means (M4) is the transit safety device of a car given in any of claims 1-4 which are characterized by being set up based on the relative horizontal deflection (deltaY) computed with the relative horizontal deflection calculation means (M2) they are.

[Claim 6] The transit safety device of a car given in any of claims 1-5 which are characterized by stopping contact evasion steering by the contact evasion means (M4) when the spontaneous contact evasion actuation by the driver is detected they are.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the transit safety device of the car which prevents that a self-vehicle contacts an oncoming car using body detection means, such as a radar installation.
[0002]
[Description of the Prior Art] The transit safety device of this car is already known by JP,7-14100,A.
[0003] What was indicated by the above-mentioned official report avoids the collision with the oncoming car which emitted the alarm for urging spontaneous collision-avoidance actuation to a driver, or braked the self-vehicle automatically, when a self-vehicle may advance into the opposite lane and it may collide with an oncoming car.
[0004]
[Problem(s) to be Solved by the Invention] By the way, the above-mentioned conventional thing presumes the amount of deviation to the opposite lane of a self-vehicle, collision possibility with an oncoming car is judged, and the amount of deviation to this opposite lane is determined mainly according to the advance azimuth (include angle of the car-body axis of a self-vehicle, and the center line of a road to accomplish) of a self-vehicle. Therefore, when a self-vehicle avoids the obstruction of a road side and performs SUTEANGU actuation utterly, for example, an incorrect judging that there is collision possibility only by the advance azimuth of a self-vehicle turning to an opposite lane side temporarily will be performed, and there is a problem which collision avoidance control unnecessary for whenever [the] is performed, and a driver senses troublesome.
[0005] This invention was made in view of the above-mentioned situation, and aims at preventing beforehand that are judging collision possibility with an oncoming car exactly, and unnecessary collision avoidance control is performed.
[0006]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, invention indicated by claim 1 A body detection means to detect the body which exists in the travelling direction of a self-vehicle, and a migration locus presumption means to presume the future migration locus of a self-vehicle, A relative horizontal deflection calculation means to compute the relative horizontal deflection of a self-vehicle and an oncoming car based on the future migration locus of the detection result by the body detection means, and said self-vehicle, A contact possibility judging means to judge with there being possibility that a self-vehicle and an oncoming car will contact when the condition that the relative horizontal deflection computed with the relative horizontal deflection calculation means is in predetermined within the limits passes beyond predetermined time, When a contact possibility judging means judges with there being possibility that a self-vehicle and an oncoming car will contact, it is characterized by having a contact evasion means to perform contact evasion steering.
[0007] According to the above-mentioned configuration, based on the condition of the oncoming car detected with the body detection means, and the future migration locus of the self-vehicle presumed with the migration locus presumption means, a relative horizontal deflection calculation means computes the relative horizontal deflection of a self-vehicle and an oncoming car. It judges with a contact possibility judging means having possibility that a self-vehicle and an oncoming car will contact if the condition that said relative horizontal deflection is in predetermined within the limits passes beyond predetermined time, and contact evasion steering is performed that a contact evasion means should avoid contact of a self-vehicle and an oncoming car. Thus, it can prevent avoiding certainly that the judgment of the contact possibility which was mistaken with temporary yaw movement of a self-vehicle without a possibility of contacting an oncoming car is performed since contact evasion steering is performed on condition that the condition that the relative horizontal deflection of a self-vehicle and an oncoming car was in predetermined within the limits passed beyond predetermined time, and unnecessary contact evasion steering being performed, and giving sense of incongruity to a driver.
[0008] Moreover, in addition to the configuration of claim 1, invention indicated by claim 2 comes to have an amount calculation means of rain deviation to compute the amount of deviation from a self-vehicle transit lane to the oncoming car transit lane of the self-vehicle in the time of a self-vehicle meeting with an oncoming car. It is characterized by judging with a contact possibility judging means having possibility that a self-vehicle and an oncoming car will contact when the amount of deviation computed with the amount calculation means of rain deviation is beyond a predetermined threshold.
[0009] Since according to the above-mentioned configuration the amount of deviation from a self-vehicle transit lane to the oncoming car transit lane of the self-vehicle in the time of a self-vehicle meeting with an oncoming car with the amount calculation means of rain deviation is computed, and it judges with there being possibility that a self-vehicle and an oncoming car will contact when this amount of deviation is beyond a predetermined threshold, compared with the case where the existence of contact possibility is judged, judgment precision can raise only by the relative relation between a self-vehicle and an oncoming car.
[0010] moreover, invention indicated by claim 3 -- the configuration of claims 1 or 2 -- in addition, said predetermined time is characterized by being set up so short that the relative velocity of a self-vehicle and an oncoming car being so large that the relative distance of a self-vehicle and an oncoming car being small.

[0011] Since it is set up so short that the relative velocity of a self-vehicle and an oncoming car is so large that the relative distance of a self-vehicle and an oncoming car is [the predetermined time which judges continuation in the condition that the relative horizontal deflection of a self-vehicle and an oncoming car is in predetermined within the limits] small according to the above-mentioned configuration, as for the case where it is thought that the possibility of contact is high, contact evasion steering can make it be easy to perform, and contact to an oncoming car can be avoided certainly.
[0012] moreover, invention indicated by claim 4 -- which configuration of claims 1-3 -- in addition, a contact evasion means is characterized by starting contact evasion steering, when time amount until a self-vehicle meets with an oncoming car becomes below a predetermined threshold.
[0013] Since according to the above-mentioned configuration contact evasion steering is started when time amount until a self-vehicle meets with an oncoming car becomes below a predetermined threshold, it is avoidable that it is early started beyond the need and contact evasion steering interferes with spontaneous contact evasion actuation of a driver.
[0014] Moreover, in addition to which configuration of claims 1-4, invention indicated by claim 5 is characterized by setting up the amount of target evasion by the contact evasion means based on the relative horizontal deflection computed with the relative horizontal deflection calculation means.
[0015] According to the above-mentioned configuration, since the amount of target evasion by the contact evasion means is set up based on the relative horizontal deflection of a self-vehicle and an oncoming car, the amount of target evasion can be set up exactly the neither more nor less.
[0016] moreover, invention indicated by claim 6 -- which configuration of claims 1-5 -- in addition, when the spontaneous contact evasion actuation by the driver is detected, it is characterized by stopping contact evasion steering by the contact evasion means.
[0017] Since according to the above-mentioned configuration contact evasion steering by the contact evasion means will be stopped if contact evasion actuation by the driver is performed, it can prevent certainly that spontaneous actuation of a driver interferes with contact evasion steering.
[0018]
[Embodiment of the Invention] Hereafter, it explains based on the example of this invention which showed the gestalt of operation of this invention to the accompanying drawing.
[0019] The whole car block diagram with which drawing 1 - drawing 11 show one example of this invention, and drawing 1 was equipped with the transit safety device, Drawing in which drawing 2 shows the block diagram of a transit safety device, and drawing 3 shows the relative relation between the self-vehicle Ai and an oncoming car Ao, Drawing in which drawing 4 shows the relative relation between the self-vehicle Ai and a transit lane, and drawing 5 The symbol description Fig. of an electronic control unit, The block diagram and drawing 7 drawing 6 explains the circuit of a head-on collision avoidance-control means to be The flow chart of a main routine, The explanatory view of technique in which drawing 8 judges the flow chart of a flag set routine, and drawing 9 judges collision possibility, and drawing 10 R> 0 are the correction factor K1 of the predetermined time Ts which judges collision possibility, and K2. The map to search and drawing 11 are the threshold tau 0 of the amount S of target horizontal evasion. It is the map to search.
[0020] As shown in drawing 1 and drawing 2 , the car equipped with the front wheels Wf and Wf on either side and the rear wheels Wr and Wr on either side is equipped with the electric power-steering equipment 2 which generates the control force for the control force which assists actuation of the steering wheel 1 for steering the front wheels Wf and Wf of the right and left which are a steering wheel, and the steering wheel 1 by the driver, and collision avoidance. the radar information processor 4 which stands in a row on a radar 3 at electronic control unit U which controls actuation of electric power-steering equipment 2, the image processing system 6 which stands in a row to a camera 5, and speed sensor S1 which detects the rotational frequency of each wheel Wf, Wf;Wr, and Wr -- and yaw rate sensor S2 which detects the yaw rate of a car body Steering torque sensor S3 which detects the steering torque added to a steering wheel 1 by the driver from -- a signal is inputted. electronic control unit U -- the radar information processor 4, an image processing system 6, and each sensor S1 --, S2, and S3 from -- while controlling actuation of electric power-steering equipment 2 based on a signal, actuation of the alarm 8 which consists of the indicator 7 and buzzer which consist of a liquid crystal display, or a lamp is controlled.
[0021] A radar 3 transmits an electromagnetic wave towards the longitudinal-direction predetermined range ahead of a self-vehicle, the reflected wave in which the electromagnetic wave was reflected by the body is received, and the radar information processor 4 which constitutes the body detection means of this invention computes the relative physical relationship of the self-vehicle Ai and an oncoming car Ao based on the signal from a radar 3. relative horizontal distance Y2 of the oncoming car [as opposed to / as shown in drawing 3 / relative-distance deltaL of the self-vehicle Ai and an oncoming car Ao, relative-velocity deltaV (namely, difference of the vehicle speed Vi of the self-vehicle Ai, and the vehicle speed Vo of an oncoming car Ao) of the self-vehicle Ai and an oncoming car Ao, and the car-body axis of the self-vehicle Ai with the relative physical relationship of the self-vehicle Ai and an oncoming car Ao] Ao it is . Relative horizontal distance Y2 Based on relative-distance deltaL of the include angle beta which the oncoming car Ao to the car-body axis of the self-vehicle Ai accomplishes, the self-vehicle Ai, and an oncoming car Ao, it is computable. Although a radar 3 detects the quiescence object of a precedence vehicle or a road in addition to an oncoming car Ao, it can distinguish an oncoming car Ao from a precedence vehicle or a quiescence object based on the magnitude of relative-velocity deltaV. In addition, in this example, the millimeter wave radar which can detect the above-mentioned relative relation (delta L, delta V, beta) between the self-vehicle Ai and an oncoming car Ao by one transmission and reception is used.
[0022] An image processing system 6 computes the distance d between the include angle theta which the car-body axis of the self-vehicle Ai to the center line of a road accomplishes based on the image ahead of the self-vehicle picturized with the camera 5, the self-vehicle Ai, and the center line, as shown in drawing 4 .
[0023] As shown in drawing 5 , electronic control unit U is equipped with the electric power-steering control means 11, the head-on collision avoidance-control means 12, a means for switching 13, and the output current decision means 14. Usually, at the time, the means for switching 13 is connected to the electric power-steering control means 11 side, and electric power-

steering equipment 2 demonstrates the usual power-steering function. That is, according to the steering torque and the vehicle speed which are inputted into a steering wheel 1, the output current decision means 14 determines the output current to an actuator 15, and a driver [control force] is assisted by outputting this output current to an actuator 15 through the drive circuit 16. On the other hand, when the self-vehicle Ai may collide head-on with an oncoming car Ao, it connects with the head-on collision avoidance-control means 12 side and a means for switching 13 controls the drive of an actuator 15 by the head-on collision avoidance-control means 12, automatic steering for avoiding the head-on collision with an oncoming car Ao is performed. The contents of this automatic steering are explained in full detail later.

[0024] As shown in drawing 6 , the migration locus presumption means M1, the relative horizontal deflection calculation means M2, the contact possibility judging means M3, the contact evasion means M4, and the amount calculation means M5 of rain deviation are formed in the interior of the head-on collision avoidance-control means 12 of electronic control unit U.

[0025] The migration locus presumption means M1 presumes the future migration locus of the self-vehicle Ai based on yaw rate gammai of the vehicle speed Vi of the self-vehicle Ai, and the self-vehicle Ai. The relative horizontal deflection calculation means M2 computes relative horizontal deflection deltaY of the self-vehicle Ai and an oncoming car Ao based on relative-distance deltaL between the self-vehicle Ai detected with future migration locus and body detection means 4 (radar information processor 4) of the self-vehicle Ai, and an oncoming car Ao, relative-velocity deltaV, and an include angle beta.

[0026] It judges with the contact possibility judging means M3 having possibility that the self-vehicle Ai and an oncoming car Ao will contact, if the condition of - epsilon<=delta Y<=epsilon passes [said relative horizontal deflection deltaY] beyond the predetermined time Ts once. At this time, the amount calculation means M5 of rain deviation computes the amount delta of deviation to the oncoming car transit lane of the self-vehicle Ai in the time of the self-vehicle Ai meeting with an oncoming car Ao, and this amount delta of deviation is the predetermined threshold delta 0. When it is above, it judges with there being possibility that the self-vehicle Ai and an oncoming car Ao will contact further in piles. Consequently, the contact evasion means M4 performs contact evasion steering that contact of the self-vehicle Ai and an oncoming car Ao should be avoided.

[0027] Next, an operation of the example of this invention is explained with reference to the flow chart of drawing 7 and drawing 8 .

[0028] First, relative horizontal distance Y2 of the oncoming car [as opposed to / to electronic control unit / from the radar information processor 4 / U / relative-distance deltaL of the self-vehicle Ai and an oncoming car Ao, relative-velocity deltaV of the self-vehicle Ai and an oncoming car Ao, and the car-body axis of the self-vehicle Ai at step S1 of the flow chart of drawing 7] Ao It reads. At continuing step S2, it is a speed sensor S1. The vehicle speed Vi and the yaw rate sensor S2 of the self-vehicle Ai detected by -- It is based on yaw rate gammai of the detected self-vehicle Ai, and is the horizontal movement magnitude Y1. It computes. As shown in drawing 9 , it is the horizontal movement magnitude Y1. It is the movement magnitude of the longitudinal direction generated when the self-vehicle Ai advances to the location of the present oncoming car Ao, and is computed as follows. Namely, horizontal movement magnitude Y1 of the self-vehicle Ai when time amount t1 =deltaL/Vi passes If yaw rate gammai of the vehicle speed Vi of the self-vehicle Ai and the self-vehicle Ai is used Y1 = (1/2) and Vi-gamma i-(deltaL/Vi) 2 -- (1)

It is come out and given.

[0029] continuing step S3 -- relative horizontal distance Y2 from -- horizontal movement magnitude Y1 Relative horizontal deflection deltaY is computed by subtracting. When the self-vehicle Ai advances to the location of the present oncoming car Ao, relative horizontal deflection deltaY is equivalent to the deflection of the longitudinal direction between the location of the present oncoming car Ao, and the estimated position of the self-vehicle Ai, so that clearly from drawing 9 . Relative horizontal deflection deltaY has the value of positive/negative, and, in the case of the left-hand traffic of this example, is Y2 >Y1. If relative horizontal deflection deltaY is forward, the presumed migration locus of the self-vehicle Ai will pass through the left-hand side of the location of the current oncoming car Ao, and it is Y2 <Y1. If relative horizontal deflection deltaY is negative, the presumed migration locus of the self-vehicle Ai will pass through the right-hand side of the location of the current oncoming car Ao. And possibility that the self-vehicle Ai will contact an oncoming car Ao will be high, so that the absolute value of this relative horizontal deflection deltaY is small.

[0030] By continuing step S4, said relative horizontal deflection deltaY judges whether it is in the range set up beforehand. That is, relative horizontal deflection deltaY is contained in the predetermined range based on the predetermined value epsilon (for example, 2m) beforehand set up based on the breadth of the car body of an automobile, therefore it is - epsilon<=delta Y<=epsilon. -- (2)

In ******(ing), it performs the 1st-step judgment that the self-vehicle Ai may collide with an oncoming car Ao. On the other hand, when the aforementioned (2) formula is not materialized, the self-vehicle Ai passes through the left-hand side or right-hand side of an oncoming car Ao, judges with a collision not occurring, and returns to step S1, without performing automatic steering for collision avoidance.

[0031] If the condition that the aforementioned (2) formula is materialized continues at continuing step S5 exceeding predetermined time Ts, the 2nd-step judgment that the self-vehicle Ai may collide with an oncoming car Ao will be performed. When the aforementioned (2) formula becomes abortive before return and predetermined time Ts passed in step S4 on the other hand until the condition that the aforementioned (2) formula was materialized exceeded predetermined time Ts, the answer of step S4 is set to NO and returns to step S1. Said predetermined time Ts is an adjustable value, and is Ts0. It considers as a reference value and is K1. And K2 It considers as a correction factor and is Ts=Ts0, K1, and K2. -- (3)

It is come out and given.

[0032] As shown in drawing 10 , it is a correction factor K1 and K2. It is searched from a map by making relative-distance deltaL or relative-velocity deltaV of the self-vehicle Ai and an oncoming car Ao into a parameter, and when said relative-distance deltaL is considered for the possibility of a collision of said relative-velocity deltaV since it is large to be high since it is small, it amends so that predetermined time Ts may be shortened. When it is thought by this that the possibility of a collision is high, the automatic steering for collision avoidance can make it be easy to perform, and the collision with an oncoming car Ao can be avoided certainly.

[0033] The condition of a deviation judging flag of expressing the size of the amount from which the self-vehicle Ai will deviate into the lane of an oncoming car Ao in the future exceeding the center line with continuing step S6 is judged. Said deviation judging flag is set to "1", when the amount of deviation to the lane of an oncoming car Ao is large and the possibility of a collision is high, when the amount of deviation to the lane of an oncoming car Ao is conversely small and the possibility of a collision is low, it is reset by "0", and it gives the explanation hereafter based on the flow chart of drawing 8 .
[0034] First, the distance d between the include angle theta which the car-body axis of the self-vehicle Ai to the center line of a road accomplishes, the self-vehicle Ai, and the center line is read from an image processing system 6 at step S21, and the amount delta of deviation to the lane of the oncoming car Ao of the self-vehicle Ai in the collision prediction point of the self-vehicle Ai and an oncoming car Ao is computed at continuing step S22.
[0035] The amount delta of deviation is given by the degree type so that clearly from drawing 9 .
[0036]
Delta=Vi-t 0 and theta+Y 1 '-d -- (4)
Here, it is t0. It is time amount until the self-vehicle Ai arrives at a collision prediction point, and is given by the degree type by doing the division of the relative-distance deltaL of the self-vehicle Ai and an oncoming car Ao by relative-velocity deltaV of the self-vehicle Ai and an oncoming car Ao.
[0037]
t0 =delta L/delta V -- (5)
(4) Vi-t0 and theta of the 1st term of the right-hand side of a formula are distance Vi-t0 from the self-vehicle Ai to a collision prediction point. The multiplication of the include angle theta which the car-body axis of the self-vehicle Ai to the center line accomplishes is carried out. Moreover, Y1 ' of the 2nd term of the right-hand side is the time amount t0 until it is horizontal movement magnitude until the self-vehicle Ai arrives at a collision prediction point and the vehicle speed Vi of the self-vehicle Ai and yaw rate gammai, and the self-vehicle Ai arrive at a collision prediction point. It uses and is given by the degree type.
[0038]
Y1 '= (1/2) and Vi-gamma i-t0 2 -- (6)
It is come out and given.
[0039] Therefore, (4) types are rewritten as follows using (6) types.
[0040]
Delta=Vi-t 0, theta+ (1/2), and Vi-gamma i-t0 2-d -- (7)
thus, threshold delta 0 which set up the amount delta of deviation beforehand at continuing step S23 when the amount delta of deviation was computed at step S22 comparing -- the amount delta of deviation -- threshold delta 0 the above -- be -- if it is, the 3rd-step judgment that the self-vehicle Ai may collide with an oncoming car Ao will be performed, and a deviation judging flag will be set to "1" at step S24. on the other hand -- said amount delta of deviation -- threshold delta 0 the following -- be -- if it is, the self-vehicle Ai will judge with there being no possibility of colliding with an oncoming car Ao, and will set a deviation judging flag to "0" at step S25.
[0041] When the deviation judging flag is set to the flow chart of drawing 7 by "1" at return and said step S6 and the self-vehicle Ai may collide with an oncoming car Ao, the amount S of target horizontal evasion for collision avoidance is computed at step S7. The amount S of target horizontal evasion should add relative horizontal deflection deltaY computed at said step S3, and the predetermined value alpha set up beforehand.
[0042]
S=delta Y+alpha -- (8)
That the initiation timing of collision avoidance control should be determined at continuing step S8, it is based on the map of drawing 11 and is a threshold tau 0 from the amount S of target horizontal evasion. It searches. Since it is necessary to suppress that superfluous lateral acceleration occurs by the automatic steering for collision avoidance, the amount S of target horizontal evasion follows on increasing, and it is a threshold tau 0. It increases. And time amount t0 until the self-vehicle Ai arrives at a collision prediction point Said threshold tau 0 If it becomes below, while operating an indicator 7 and an alarm 8 by step S9 and emitting an alarm to a driver, automatic steering for collision avoidance is performed.
[0043] If it will be detected that the driver operated the steering wheel 1, for example by the steering torque sensor if spontaneous collision-avoidance actuation of a driver is detected at step S10 or it is detected that the driver braked by the treading strength sensor of a brake pedal while performing automatic steering for collision avoidance, the automatic steering for an alarm or collision avoidance will be stopped by step S11. It can be prevented that spontaneous collision-avoidance actuation of a driver interferes with automatic steering by this, it can give priority to collision-avoidance actuation of a driver, and can cancel sense of incongruity.
[0044] The judgment of the collision possibility of the self-vehicle Ai and an oncoming car Ao to a three-stage As mentioned above, another **** deed, It checks that it is within limits which relative horizontal deflection deltaY set up beforehand by said step S4 first. Subsequently, it checks that the condition has carried out predetermined time Ts continuation at step S5, and the amount delta of deviation to the opposite lane of the self-vehicle Ai is a threshold delta 0 at step S6 further. Since it checks that it is above, the judgment of the collision possibility finally given can be made very highly precise. Since it checks that the condition of being within limits which relative horizontal deflection deltaY set up beforehand especially has carried out predetermined time Ts continuation, it can prevent that the judgment of the contact possibility which was mistaken with temporary yaw movement of the self-vehicle Ai is performed.
[0045] As mentioned above, although the example of this invention was explained in full detail, this invention can perform design changes various in the range which does not deviate from the summary.
[0046]
[Effect of the Invention] Since according to invention indicated by claim 1 as mentioned above contact evasion steering is performed on condition that the condition that the relative horizontal deflection of a self-vehicle and an oncoming car was in predetermined within the limits passed beyond predetermined time It can prevent avoiding certainly that the judgment of the

contact possibility which was mistaken with temporary yaw movement of a self-vehicle without a possibility of contacting an oncoming car is performed, and unnecessary contact evasion steering being performed, and giving sense of incongruity to a driver.

[0047] Moreover, according to invention indicated by claim 2, the amount of deviation from a self-vehicle transit lane to the oncoming car transit lane of the self-vehicle in the time of a self-vehicle meeting with an oncoming car with the amount calculation means of rain deviation is computed. Since it judges with there being possibility that a self-vehicle and an oncoming car will contact when this amount of deviation is beyond a predetermined threshold, compared with the case where the existence of contact possibility is judged, judgment precision can be raised only by the relative relation between a self-vehicle and an oncoming car.

[0048] Moreover, since it is set up so short that the relative velocity of a self-vehicle and an oncoming car is so large that the relative distance of a self-vehicle and an oncoming car is [the predetermined time which judges continuation in the condition that the relative horizontal deflection of a self-vehicle and an oncoming car is in predetermined within the limits] small according to invention indicated by claim 3, as for the case where it is thought that the possibility of contact is high, contact evasion steering can make it be easy to perform, and contact to an oncoming car can be avoided certainly.

[0049] Moreover, since according to invention indicated by claim 4 contact evasion steering is started when time amount until a self-vehicle meets with an oncoming car becomes below a predetermined threshold, it is avoidable that it is early started beyond the need and contact evasion steering interferes with spontaneous contact evasion actuation of a driver.

[0050] Moreover, according to invention indicated by claim 5, since the amount of target evasion by the contact evasion means is set up based on the relative horizontal deflection of a self-vehicle and an oncoming car, the amount of target evasion can be set up exactly the neither more nor less.

[0051] Moreover, since according to invention indicated by claim 6 contact evasion steering by the contact evasion means will be stopped if contact evasion actuation by the driver is performed, it can prevent certainly that spontaneous actuation of a driver interferes with contact evasion steering.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The car whole block diagram equipped with the transit safety device
[Drawing 2] The block diagram of a transit safety device
[Drawing 3] Drawing showing the relative relation between the self-vehicle Ai and an oncoming car Ao
[Drawing 4] Drawing showing the relative relation between the self-vehicle Ai and a transit lane
[Drawing 5] The symbol description Fig. of an electronic control unit
[Drawing 6] The block diagram explaining the circuit of a head-on collision avoidance-control means
[Drawing 7] The flow chart of a main routine
[Drawing 8] The flow chart of a flag set routine
[Drawing 9] The explanatory view of the technique of judging collision possibility
[Drawing 10] The correction factor K1 of the predetermined time Ts which judges collision possibility, and K2 Map to search
[Drawing 11] Threshold tau 0 of the amount S of target horizontal evasion Map to search
[Description of Notations]
4 Radar Information Processor (Body Detection Means)
Ai Self-vehicle
Ao Oncoming car
M1 Migration locus presumption means
M2 Relative horizontal deflection calculation means
M3 Contact possibility judging means
M4 Contact evasion means
M5 The amount calculation means of rain deviation
S The amount of target evasion
Ts Predetermined time
t0 Time amount until a self-vehicle meets with an oncoming car
delta The amount of deviation
delta 0 Threshold
- Epsilon-epsilon Predetermined range
tau 0 Threshold
deltaL Relative distance
deltaY Relative horizontal deflection
deltaV Relative velocity

[Translation done.]

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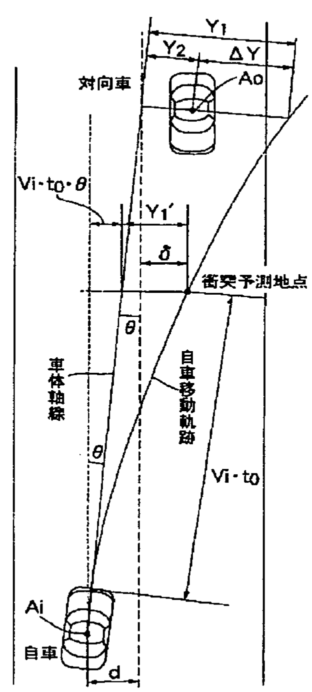
(54)【発明の名称】　車両の走行安全装置

(57)【要約】
【課題】　対向車との衝突可能性の判定を的確に行って不必要な衝突回避制御が実行されるのを未然に防止する。
【解決手段】　自車Ａｉの車速Ｖｉおよびヨーレートγｉに基づいて自車Ａｉが現在の対向車Ａｏの位置まで進行したときの横移動量Y_1を算出するとともに、レーダー情報処理装置で検出した自車Ａｉと対向車Ａｏとの相対距離、相対速度および相対角度に基づいて、自車Ａｉの車体軸線に対する対向車Ａｏの相対横距離Y_2を算出する。相対横距離Y_2から横移動量Y_1を減算した相対横偏差ΔＹが$-\varepsilon \leqq \Delta Y \leqq \varepsilon$の範囲にあり、且つその状態が所定時間Ｔｓを越えて継続すると、自車Ａｉが対向車Ａｏに衝突する可能性があると判定して衝突回避のための自動操舵を実行する。



【特許請求の範囲】

【請求項１】　自車（Ａｉ）の進行方向に存在する物体を検出する物体検出手段（４）と、

自車（Ａｉ）の将来の移動軌跡を推定する移動軌跡推定手段（Ｍ１）と、

物体検出手段（４）による検出結果および前記自車（Ａｉ）の将来の移動軌跡に基づいて自車（Ａｉ）と対向車（Ａｏ）との相対横偏差（ΔＹ）を算出する相対横偏差算出手段（Ｍ２）と、

相対横偏差算出手段（Ｍ２）で算出した相対横偏差（ΔＹ）が所定範囲（$-\varepsilon \sim \varepsilon$）内にある状態が所定時間（Ｔｓ）以上経過したときに自車（Ａｉ）と対向車（Ａｏ）とが接触する可能性が有ると判定する接触可能性判定手段（Ｍ３）と、

接触可能性判定手段（Ｍ３）が自車（Ａｉ）と対向車（Ａｏ）とが接触する可能性が有ると判定したときに接触回避操舵を行なう接触回避手段（Ｍ４）と、を備えたことを特徴とする車両の走行安全装置。

【請求項２】　自車（Ａｉ）が対向車（Ａｏ）に出会う時点での自車（Ａｉ）の自車走行レーンから対向車走行レーンへの逸脱量（δ）を算出するレーン逸脱量算出手段（Ｍ５）を備えてなり、

接触可能性判定手段（Ｍ３）は、レーン逸脱量算出手段（Ｍ５）で算出した逸脱量（δ）が所定の閾値（δ_0）以上のときに自車（Ａｉ）と対向車（Ａｏ）とが接触する可能性が有ると判定することを特徴とする、請求項１に記載の車両の走行安全装置。

【請求項３】　前記所定時間（Ｔｓ）は、自車（Ａｉ）と対向車（Ａｏ）との相対距離（ΔＬ）が小さいほど、あるいは自車（Ａｉ）と対向車（Ａｏ）との相対速度（ΔＶ）が大きいほど短く設定されることを特徴とする、請求項１または２に記載の車両の走行安全装置。

【請求項４】　接触回避手段（Ｍ４）は、自車（Ａｉ）が対向車（Ａｏ）に出会うまでの時間（t_0）が所定の閾値（τ_0）以下になったときに接触回避操舵を開始することを特徴とする、請求項１～３の何れかに記載の車両の走行安全装置。

【請求項５】　接触回避手段（Ｍ４）による目標回避量（Ｓ）は、相対横偏差算出手段（Ｍ２）で算出した相対横偏差（ΔＹ）に基づいて設定されることを特徴とする、請求項１～４の何れかに記載の車両の走行安全装置。

【請求項６】　ドライバーによる自発的な接触回避操作が検出されたときに接触回避手段（Ｍ４）による接触回避操舵を中止することを特徴とする、請求項１～５の何れかに記載の車両の走行安全装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、レーダー装置等の物体検出手段を用いて自車が対向車に接触するのを防止する車両の走行安全装置に関する。

【０００２】

【従来の技術】かかる車両の走行安全装置は、特開平７－１４１００号公報により既に知られている。

【０００３】上記公報に記載されたものは、自車が対向車線に進入して対向車と衝突する可能性がある場合に、ドライバーに自発的な衝突回避操作を促すための警報を発したり、自車を自動的に制動したりした対向車との衝突を回避するようになっている。

【０００４】

【発明が解決しようとする課題】ところで、上記従来のものは自車の対向車線への逸脱量を推定して対向車との衝突可能性の判定を行うようになっており、この対向車線への逸脱量は主として自車の進行方位角（自車の車体軸線と道路のセンターラインとの成す角度）に応じて決定される。そのために、例えば自車が路側の障害物を避けようとしてステアング操作を行ったような場合に、自車の進行方位角が一時的に対向車線側に向いただけで衝突可能性が有るとの誤判定が行われてしまい、その度に不必要な衝突回避制御が実行されてドライバーが煩わしく感じる問題がある。

【０００５】本発明は前述の事情に鑑みてなされたもので、対向車との衝突可能性の判定を的確に行って不必要な衝突回避制御が実行されるのを未然に防止することを目的とする。

【０００６】

【課題を解決するための手段】上記目的を達成するために、請求項１に記載された発明は、自車の進行方向に存在する物体を検出する物体検出手段と、自車の将来の移動軌跡を推定する移動軌跡推定手段と、物体検出手段による検出結果および前記自車の将来の移動軌跡に基づいて自車と対向車との相対横偏差を算出する相対横偏差算出手段と、相対横偏差算出手段で算出した相対横偏差が所定範囲内にある状態が所定時間以上経過したときに自車と対向車とが接触する可能性が有ると判定する接触可能性判定手段と、接触可能性判定手段が自車と対向車とが接触する可能性が有ると判定したときに接触回避操舵を行なう接触回避手段とを備えたことを特徴とする。

【０００７】上記構成によれば、物体検出手段で検出した対向車の状態と、移動軌跡推定手段で推定した自車の将来の移動軌跡とに基づいて、相対横偏差算出手段が自車と対向車との相対横偏差を算出する。接触可能性判定手段は、前記相対横偏差が所定範囲内にある状態が所定時間以上経過すると自車と対向車とが接触する可能性が有ると判定し、接触回避手段が自車および対向車の接触を回避すべく接触回避操舵を行う。このように自車と対向車との相対横偏差が所定範囲内にある状態が所定時間以上経過したことを条件にして接触回避操舵を実行するので、対向車と接触する虞がない自車の一時的なヨー運動に伴って誤った接触可能性の判定が行われるのを確実

に回避し、不必要な接触回避操舵が実行されてドライバーに違和感を与えるのを防止することができる。

【０００８】また請求項２に記載された発明は、請求項１の構成に加えて、自車が対向車に出会う時点での自車の自車走行レーンから対向車走行レーンへの逸脱量を算出するレーン逸脱量算出手段を備えてなり、接触可能性判定手段は、レーン逸脱量算出手段で算出した逸脱量が所定の閾値以上のときに自車と対向車とが接触する可能性が有ると判定することを特徴とする。

【０００９】上記構成によれば、レーン逸脱量算出手段により自車が対向車に出会う時点での自車の自車走行レーンから対向車走行レーンへの逸脱量を算出し、この逸脱量が所定の閾値以上のときに自車と対向車とが接触する可能性が有ると判定するので、自車および対向車の相対関係だけで接触可能性の有無を判定する場合に比べて判定精度を高めることができる。

【００１０】また請求項３に記載された発明は、請求項１または２の構成に加えて、前記所定時間は、自車と対向車との相対距離が小さいほど、あるいは自車と対向車との相対速度が大きいほど短く設定されることを特徴とする。

【００１１】上記構成によれば、自車と対向車との相対横偏差が所定範囲内にある状態の継続を判定する所定時間が、自車と対向車との相対距離が小さいほど、あるいは自車と対向車との相対速度が大きいほど短く設定されるので、接触の可能性が高いと思われる場合ほど接触回避操舵が実行され易くして対向車との接触を確実に回避することができる。

【００１２】また請求項４に記載された発明は、請求項１～３の何れかの構成に加えて、接触回避手段は、自車が対向車に出会うまでの時間が所定の閾値以下になったときに接触回避操舵を開始することを特徴とする。

【００１３】上記構成によれば、自車が対向車に出会うまでの時間が所定の閾値以下になったときに接触回避操舵を開始するので、接触回避操舵が必要以上に早く開始されてドライバーの自発的な接触回避操作と干渉するのを回避することができる。

【００１４】また請求項５に記載された発明は、請求項１～４の何れかの構成に加えて、接触回避手段による目標回避量は、相対横偏差算出手段で算出した相対横偏差に基づいて設定されることを特徴とする。

【００１５】上記構成によれば、接触回避手段による目標回避量を自車と対向車との相対横偏差に基づいて設定するので、目標回避量を過不足なく的確に設定することができる。

【００１６】また請求項６に記載された発明は、請求項１～５の何れかの構成に加えて、ドライバーによる自発的な接触回避操作が検出されたときに接触回避手段による接触回避操舵を中止することを特徴とする。

【００１７】上記構成によれば、ドライバーによる接触回避操作が行われると接触回避手段による接触回避操舵が中止されるので、ドライバーの自発的な操作が接触回避操舵と干渉するのを確実に防止することができる。

【００１８】

【発明の実施の形態】以下、本発明の実施の形態を、添付図面に示した本発明の実施例に基づいて説明する。

【００１９】図１～図１１は本発明の一実施例を示すもので、図１は走行安全装置を備えた車両の全体構成図、図２は走行安全装置のブロック図、図３は自車Ａｉおよび対向車Ａｏの相対関係を示す図、図４は自車Ａｉおよび走行レーンの相対関係を示す図、図５は電子制御ユニットの機能の説明図、図６は正面衝突回避制御手段の回路を説明するブロック図、図７はメインルーチンのフローチャート、図８はフラグセットルーチンのフローチャート、図９は衝突可能性を判定する手法の説明図、図１０は衝突可能性を判定する所定時間Ｔｓの補正係数 K_1 ，K_2 を検索するマップ、図１１は目標横回避量Ｓの閾値 τ_0 を検索するマップである。

【００２０】図１および図２に示すように、左右の前輪Ｗｆ，Ｗｆおよび左右の後輪Ｗｒ，Ｗｒを備えた車両は、操舵輪である左右の前輪Ｗｆ，Ｗｆを操舵するためのステアリングホイール１と、ドライバーによるステアリングホイール１の操作をアシストする操舵力および衝突回避のための操舵力を発生する電動パワーステアリング装置２とを備える。電動パワーステアリング装置２の作動を制御する電子制御ユニットＵには、レーダー３に連なるレーダー情報処理装置４と、カメラ５に連なる画像処理装置６と、各車輪Ｗｆ，Ｗｆ；Ｗｒ，Ｗｒの回転数を検出する車速センサ S_1 …と、車体のヨーレートを検出するヨーレートセンサ S_2 と、ドライバーによりステアリングホイール１に加えられる操舵トルクを検出する操舵トルクセンサ S_3 とからの信号が入力される。電子制御ユニットＵは、レーダー情報処理装置４、画像処理装置６および各センサ S_1 …，S_2 ，S_3 からの信号に基づいて電動パワーステアリング装置２の作動を制御するとともに、液晶ディスプレイよりなる表示器７およびブザーやランプよりなる警報器８の作動を制御する。

【００２１】レーダー３は自車前方の左右方向所定範囲に向けて電磁波を送信し、その電磁波が物体に反射された反射波を受信するもので、本発明の物体検出手段を構成するレーダー情報処理装置４は、レーダー３からの信号に基づいて自車Ａｉおよび対向車Ａｏの相対的な位置関係を算出する。図３に示すように、自車Ａｉおよび対向車Ａｏの相対的な位置関係とは、自車Ａｉおよび対向車Ａｏの相対距離ΔＬと、自車Ａｉおよび対向車Ａｏの相対速度ΔＶ（すなわち、自車Ａｉの車速Ｖｉと対向車Ａｏの車速Ｖｏとの差）と、自車Ａｉの車体軸線に対する対向車Ａｏの相対横距離 Y_2 とである。相対横距離 Y_2 は、自車Ａｉの車体軸線に対する対向車Ａｏの成す角度βと、自車Ａｉおよび対向車Ａｏの相対距離ΔＬとに

基づいて算出可能である。レーダー３は対向車Ａｏ以外に先行車や道路の静止物を検出するが、相対速度ΔＶの大きさに基づいて先行車や静止物から対向車Ａｏを判別することができる。尚、本実施例では、１回の送受信で自車Ａｉと対向車Ａｏとの上記相対関係（ΔＬ，ΔＶ，β）を検出することができるミリ波レーダーが用いられる。

【００２２】画像処理装置６は、図４に示すように、カメラ５で撮像した自車前方の画像に基づいて道路のセンターラインに対する自車Ａｉの車体軸線の成す角度θと、自車Ａｉおよびセンターライン間の距離ｄとを算出する。

【００２３】図５に示すように、電子制御ユニットＵは電動パワーステアリング制御手段１１と、正面衝突回避制御手段１２と、切換手段１３と、出力電流決定手段１４とを備える。通常時は切換手段１３が電動パワーステアリング制御手段１１側に接続されており、電動パワーステアリング装置２は通常のパワーステアリング機能を発揮する。すなわち、ステアリングホイール１に入力される操舵トルクと車速とに応じて出力電流決定手段１４がアクチュエータ１５への出力電流を決定し、この出力電流を駆動回路１６を介してアクチュエータ１５に出力することによりドライバーの操舵力をアシストする。一方、自車Ａｉが対向車Ａｏと正面衝突する可能性がある場合には切換手段１３が正面衝突回避制御手段１２側に接続され、正面衝突回避制御手段１２でアクチュエータ１５の駆動を制御することにより、対向車Ａｏとの正面衝突を回避するための自動操舵が実行される。この自動操舵の内容は後から詳述する。

【００２４】図６に示すように、電子制御ユニットＵの正面衝突回避制御手段１２の内部には、移動軌跡推定手段Ｍ１と、相対横偏差算出手段Ｍ２と、接触可能性判定手段Ｍ３と、接触回避手段Ｍ４と、レーン逸脱量算出手段Ｍ５とが設けられる。

【００２５】移動軌跡推定手段Ｍ１は、自車Ａｉの車速Ｖｉおよび自車Ａｉのヨーレートγｉに基づいて自車Ａｉの将来の移動軌跡を推定する。相対横偏差算出手段Ｍ２は、自車Ａｉの将来の移動軌跡と、物体検出手段４（レーダー情報処理装置４）で検出した自車Ａｉおよび対向車Ａｏ間の相対距離ΔＬ、相対速度ΔＶおよび角度βとに基づいて、自車Ａｉおよび対向車Ａｏの相対横偏差ΔＹを算出する。

【００２６】接触可能性判定手段Ｍ３は、前記相対横偏差ΔＹが$-\varepsilon \leqq \Delta Y \leqq \varepsilon$の状態が所定時間Ｔｓ以上経過すると、自車Ａｉおよび対向車Ａｏが接触する可能性が有ると一応判定する。このとき、レーン逸脱量算出手段Ｍ５は、自車Ａｉが対向車Ａｏに出会う時点での自車Ａｉの対向車走行レーンへの逸脱量δを算出し、この逸脱量δが所定の閾値δ_0以上のときに自車Ａｉおよび対向車Ａｏが接触する可能性が有ると更に重ねて判定する。その結果、接触回避手段Ｍ４が、自車Ａｉおよび対向車Ａｏの接触を回避すべく接触回避操舵を実行する。

【００２７】次に、本発明の実施例の作用を図７および図８のフローチャートを参照して説明する。

【００２８】先ず、図７のフローチャートのステップＳ１で、レーダー情報処理装置４から電子制御ユニットＵに自車Ａｉおよび対向車Ａｏの相対距離ΔＬと、自車Ａｉおよび対向車Ａｏの相対速度ΔＶと、自車Ａｉの車体軸線に対する対向車Ａｏの相対横距離Y_2とを読み込む。続くステップＳ２で、車速センサS_1…で検出した自車Ａｉの車速Ｖｉと、ヨーレートセンサS_2で検出した自車Ａｉのヨーレートγｉとに基づいて横移動量Y_1を算出する。図９に示すように、横移動量Y_1は、自車Ａｉが現在の対向車Ａｏの位置まで進行したときに発生する横方向の移動量であって、次のようにして算出される。すなわち、時間$t_1 = \Delta L / Vi$が経過したときの自車Ａｉの横移動量Y_1は、自車Ａｉの車速Ｖｉおよび自車Ａｉのヨーレートγｉを用いると、

$$Y_1 = (1/2) \cdot Vi \cdot \gamma i \cdot (\Delta L / Vi)^2 \quad \cdots (1)$$

で与えられる。

【００２９】続くステップＳ３で、相対横距離Y_2から横移動量Y_1を減算することにより、相対横偏差ΔＹを算出する。図９から明らかなように、相対横偏差ΔＹは、自車Ａｉが現在の対向車Ａｏの位置まで進行したときに、現在の対向車Ａｏの位置と、自車Ａｉの推定位置との間の横方向の偏差に相当する。相対横偏差ΔＹは正負の値を持ち、本実施例の左側通行の場合には、$Y_2 > Y_1$で相対横偏差ΔＹが正であれば自車Ａｉの推定移動軌跡は現在の対向車Ａｏの位置の左側を通過し、$Y_2 < Y_1$で相対横偏差ΔＹが負であれば自車Ａｉの推定移動軌跡は現在の対向車Ａｏの位置の右側を通過する。そして、この相対横偏差ΔＹの絶対値が小さいほど、自車Ａｉが対向車Ａｏに接触する可能性が高いことになる。

【００３０】続くステップＳ４で、前記相対横偏差ΔＹが予め設定した範囲にあるか否かを判定する。すなわち、自動車の車体の横幅に基づいて予め設定した所定値ε（例えば２ｍ）に基づく所定範囲に相対横偏差ΔＹが入っており、従って、

$$-\varepsilon \leqq \Delta Y \leqq \varepsilon \quad \cdots (2)$$

が成立する場合には、自車Ａｉが対向車Ａｏに衝突する可能性があるとの第１段階の判定を行う。一方、前記（２）式が成立しないときには、自車Ａｉが対向車Ａｏの左側あるいは右側をすり抜けて衝突が発生しないと判定して、衝突回避のための自動操舵を実行せずにステップＳ１に復帰する。

【００３１】続くステップＳ５で、前記（２）式が成立している状態が所定時間Ｔｓを越えて継続すれば、自車Ａｉが対向車Ａｏに衝突する可能性があるとの第２段階の判定を行う。一方、前記（２）式が成立している状態

が所定時間Ｔｓを越えるまではステップＳ４に戻り、所定時間Ｔｓが経過する前に前記（２）式が不成立になった場合には、ステップＳ４の答えがＮＯになってステップＳ１に復帰する。前記所定時間Ｔｓは可変値であり、Ts_0 を基準値とし、K_1 およびK_2 を補正係数として、

$$Ts = Ts_0 \cdot K_1 \cdot K_2 \quad \cdots (3)$$

で与えられる。

【００３２】図１０に示すように、補正係数K_1 ，K_2 は自車Ａｉおよび対向車Ａｏの相対距離ΔＬあるいは相対速度ΔＶをパラメータとしてマップから検索されるもので、前記相対距離ΔＬが小さいために、あるいは前記相対速度ΔＶが大きいために衝突の可能性が高いと思われる場合に所定時間Ｔｓを短縮するように補正する。これにより、衝突の可能性が高いと思われる場合に衝突回避のための自動操舵が実行され易くし、対向車Ａｏとの衝突を確実に回避することができる。

【００３３】続くステップＳ６で、自車Ａｉが将来センターラインを越えて対向車Ａｏの車線に逸脱する量の大小を表す逸脱判定フラグの状態を判定する。前記逸脱判定フラグは、対向車Ａｏの車線への逸脱量が大きくて衝突の可能性が高い場合に「１」にセットされ、逆に対向車Ａｏの車線への逸脱量が小さくて衝突の可能性が低い場合に「０」にリセットされるものであり、以下、図８のフローチャートに基づいてその説明を行う。

【００３４】先ず、ステップＳ２１で、画像処理装置６から道路のセンターラインに対する自車Ａｉの車体軸線の成す角度θと、自車Ａｉおよびセンターライン間の距離ｄとを読み込み、続くステップＳ２２で、自車Ａｉおよび対向車Ａｏの衝突予測地点における、自車Ａｉの対向車Ａｏの車線への逸脱量δを算出する。

【００３５】図９から明らかなように、逸脱量δは次式で与えられる。

【００３６】

$$\delta = Vi \cdot t_0 \cdot \theta + Y_1{}' - d \quad \cdots (4)$$

ここで、t_0 は自車Ａｉが衝突予測地点に達するまでの時間であって、自車Ａｉおよび対向車Ａｏの相対距離ΔＬを、自車Ａｉおよび対向車Ａｏの相対速度ΔＶで除算することにより、次式で与えられるものである。

【００３７】

$$t_0 = \Delta L / \Delta V \quad \cdots (5)$$

（４）式の右辺第１項の$Vi \cdot t_0 \cdot \theta$は、自車Ａｉから衝突予測地点までの距離$Vi \cdot t_0$ に、センターラインに対する自車Ａｉの車体軸線の成す角度θを乗算したものである。また右辺第２項の$Y_1{}'$ は、自車Ａｉが衝突予測地点に達するまでの横移動量であって、自車Ａｉの車速Ｖｉおよびヨーレートγｉと、自車Ａｉが衝突予測地点に達するまでの時間t_0 とを用いて、次式により与えられる。

【００３８】

$$Y_1{}' = (1/2) \cdot Vi \cdot \gamma i \cdot t_0{}^2 \quad \cdots (6)$$

で与えられる。

【００３９】従って、（６）式を用いて（４）式は次のように書き換えられる。

【００４０】

$$\delta = Vi \cdot t_0 \cdot \theta + (1/2) \cdot Vi \cdot \gamma i \cdot t_0{}^2 - d \quad \cdots (7)$$

このようにして、ステップＳ２２で逸脱量δが算出されると、続くステップＳ２３で逸脱量δを予め設定した閾値δ_0 と比較し、逸脱量δが閾値δ_0 以上であれあれば自車Ａｉが対向車Ａｏに衝突する可能性があるとの第３段階の判定を行い、ステップＳ２４で逸脱判定フラグを「１」にセットする。一方、前記逸脱量δが閾値δ_0 未満であれあれば自車Ａｉが対向車Ａｏに衝突する可能性が無いと判定し、ステップＳ２５で逸脱判定フラグを「０」にセットする。

【００４１】図７のフローチャートに戻り、前記ステップＳ６で逸脱判定フラグが「１」にセットされていて自車Ａｉが対向車Ａｏに衝突する可能性がある場合には、ステップＳ７で衝突回避のための目標横回避量Ｓを算出する。目標横回避量Ｓは、前記ステップＳ３で算出した相対横偏差ΔＹと、予め設定した所定値αとを加算したものとする。

【００４２】

$$S = \Delta Y + \alpha \quad \cdots (8)$$

続くステップＳ８で、衝突回避制御の開始タイミングを決定すべく、図１１のマップに基づいて目標横回避量Ｓから閾値τ_0 を検索する。衝突回避のための自動操舵により過剰な横加速度が発生するのを抑える必要があるため、目標横回避量Ｓが増加するに伴って閾値τ_0 も増加する。そして自車Ａｉが衝突予測地点に達するまでの時間t_0 が前記閾値τ_0 以下になると、ステップＳ９で表示器７および警報器８を作動させてドライバーに警報を発するとともに、衝突回避のための自動操舵を実行する。

【００４３】衝突回避のための自動操舵を実行している間に、ステップＳ１０でドライバーの自発的な衝突回避操作が検出されると、例えば操舵トルクセンサによりドライバーがステアリングホイール１を操作したことが検出されたり、ブレーキペダルの踏力センサによりドライバーが制動を行ったことが検出されると、ステップＳ１１で警報や衝突回避のための自動操舵を中止する。これにより、ドライバーの自発的な衝突回避操作が自動操舵と干渉するのが防止され、ドライバーの衝突回避操作を優先して違和感を解消することができる。

【００４４】以上のように、自車Ａｉと対向車Ａｏとの衝突可能性の判定を３段階に別けて行い、先ず前記ステ

ップＳ４で相対横偏差ΔＹが予め設定した範囲内にあることを確認し、次いでステップＳ５でその状態が所定時間Ｔｓ継続したことを確認し、更にステップＳ６で自車Ａｉの対向車線への逸脱量δが閾値δ_0以上であることを確認するので、最終的に下される衝突可能性の判定を極めて高精度なものとすることができる。特に、相対横偏差ΔＹが予め設定した範囲内にある状態が所定時間Ｔｓ継続したことを確認するので、自車Ａｉの一時的なヨー運動に伴って誤った接触可能性の判定が行われるのを防止することができる。

【００４５】以上、本発明の実施例を詳述したが、本発明はその要旨を逸脱しない範囲で種々の設計変更を行うことが可能である。

【００４６】

【発明の効果】以上のように請求項１に記載された発明によれば、自車と対向車との相対横偏差が所定範囲内にある状態が所定時間以上経過したことを条件にして接触回避操舵を実行するので、対向車と接触する虞がない自車の一時的なヨー運動に伴って誤った接触可能性の判定が行われるのを確実に回避し、不必要な接触回避操舵が実行されてドライバーに違和感を与えるのを防止することができる。

【００４７】また請求項２に記載された発明によれば、レーン逸脱量算出手段により自車が対向車に出会う時点での自車の自車走行レーンから対向車走行レーンへの逸脱量を算出し、この逸脱量が所定の閾値以上のときに自車と対向車とが接触する可能性が有ると判定するので、自車および対向車の相対関係だけで接触可能性の有無を判定する場合に比べて判定精度を高めることができる。

【００４８】また請求項３に記載された発明によれば、自車と対向車との相対横偏差が所定範囲内にある状態の継続を判定する所定時間が、自車と対向車との相対距離が小さいほど、あるいは自車と対向車との相対速度が大きいほど短く設定されるので、接触の可能性が高いと思われる場合ほど接触回避操舵が実行され易くして対向車との接触を確実に回避することができる。

【００４９】また請求項４に記載された発明によれば、自車が対向車に出会うまでの時間が所定の閾値以下になったときに接触回避操舵を開始するので、接触回避操舵が必要以上に早く開始されてドライバーの自発的な接触回避操作と干渉するのを回避することができる。

【００５０】また請求項５に記載された発明によれば、接触回避手段による目標回避量を自車と対向車との相対横偏差に基づいて設定するので、目標回避量を過不足なく的確に設定することができる。

【００５１】また請求項６に記載された発明によれば、ドライバーによる接触回避操作が行われると接触回避手段による接触回避操舵が中止されるので、ドライバーの自発的な操作が接触回避操舵と干渉するのを確実に防止することができる。

【図面の簡単な説明】

【図１】走行安全装置を備えた車両の全体構成図

【図２】走行安全装置のブロック図

【図３】自車Ａｉおよび対向車Ａｏの相対関係を示す図

【図４】自車Ａｉおよび走行レーンの相対関係を示す図

【図５】電子制御ユニットの機能の説明図

【図６】正面衝突回避制御手段の回路を説明するブロック図

【図７】メインルーチンのフローチャート

【図８】フラグセットルーチンのフローチャート

【図９】衝突可能性を判定する手法の説明図

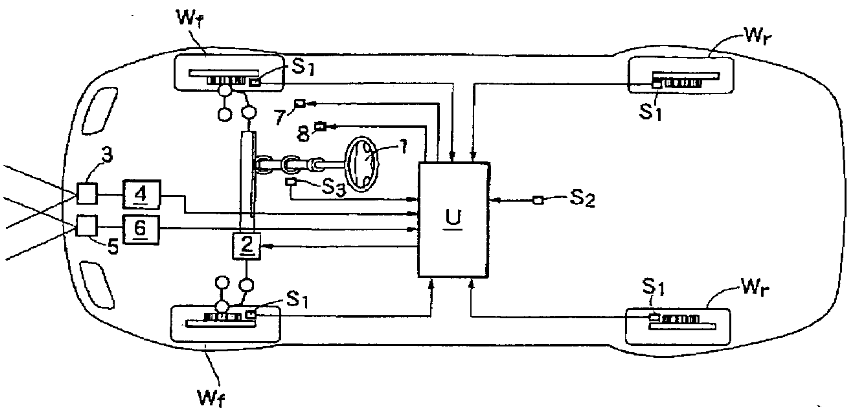
【図１０】衝突可能性を判定する所定時間Ｔｓの補正係数K_1，K_2を検索するマップ

【図１１】目標横回避量Ｓの閾値τ_0を検索するマップ

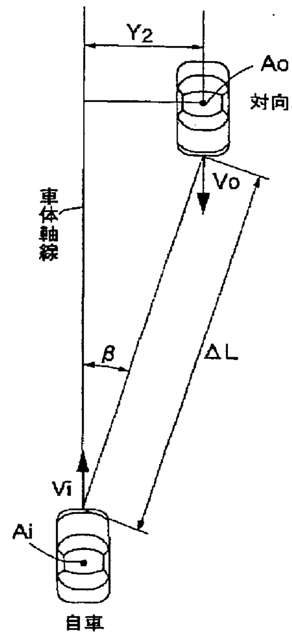
【符号の説明】

4	レーダー情報処理装置（物体検出手段）
Ａｉ	自車
Ａｏ	対向車
Ｍ１	移動軌跡推定手段
Ｍ２	相対横偏差算出手段
Ｍ３	接触可能性判定手段
Ｍ４	接触回避手段
Ｍ５	レーン逸脱量算出手段
Ｓ	目標回避量
Ｔｓ	所定時間
t_0	自車が対向車に出会うまでの時間
δ	逸脱量
δ_0	閾値
$-\varepsilon \sim \varepsilon$	所定範囲
τ_0	閾値
ΔＬ	相対距離
ΔＹ	相対横偏差
ΔＶ	相対速度

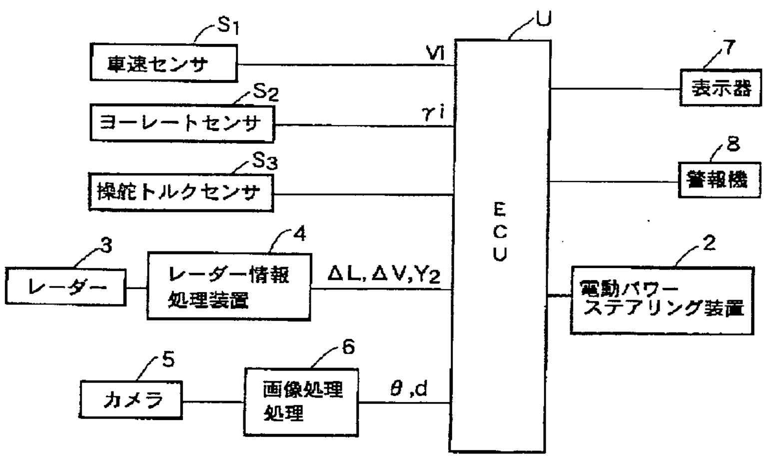
【図１】


Wf
S1
Wr
7
8
1
3
4
S3
U
S2
6
5
2
S1
Wf

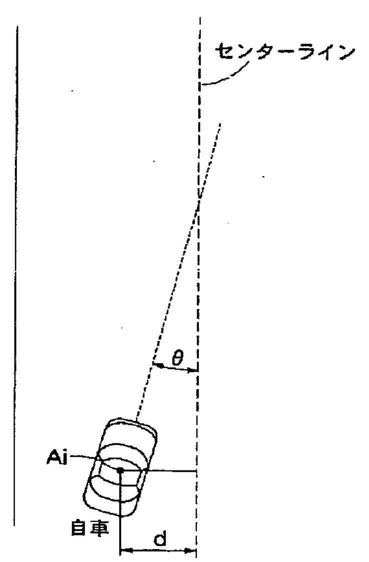
【図３】


Y2
Ao
対向車
Vo
車体軸線
β
ΔL
Vi
Ai
自車

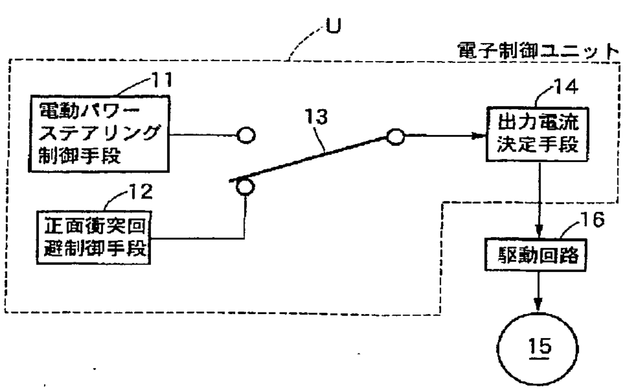
【図２】


S1
車速センサ
Vi
U
S2
ヨーレートセンサ
γi
7
表示器
S3
操舵トルクセンサ
8
警報機
ECU
3
レーダー
4
レーダー情報処理装置
ΔL, ΔV, Y2
2
電動パワーステアリング装置
5
カメラ
6
画像処理処理
θ, d

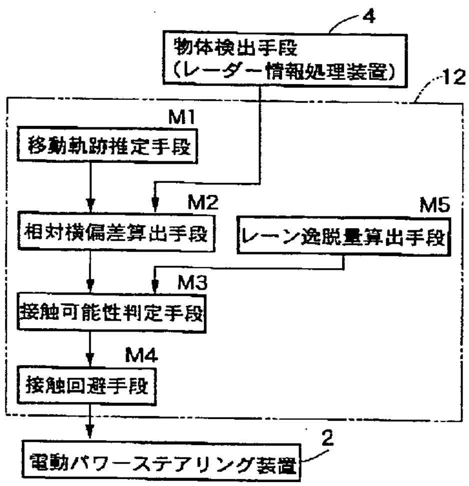
【図４】


センターライン
θ
Ai
自車
d

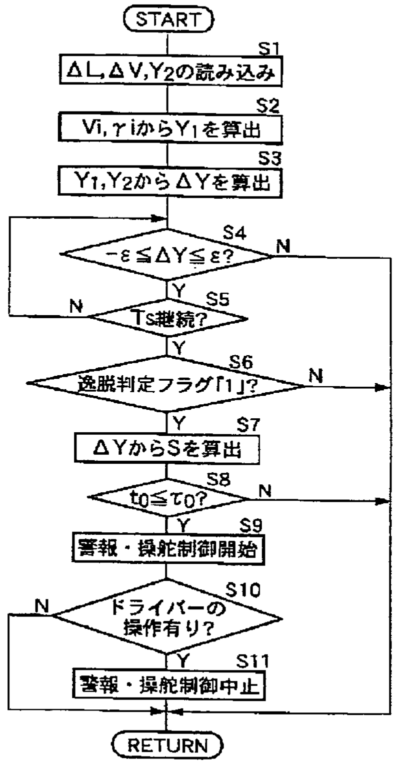
【図５】


U
電子制御ユニット
11
電動パワーステアリング制御手段
13
14
出力電流決定手段
12
正面衝突回避制御手段
16
駆動回路
15

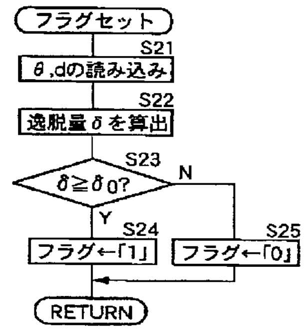
【図６】



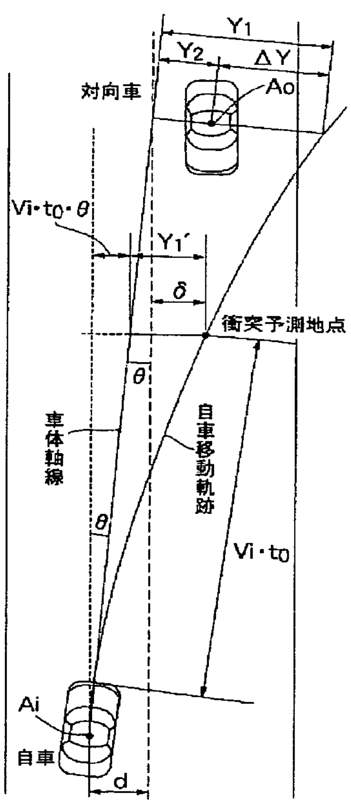
【図７】



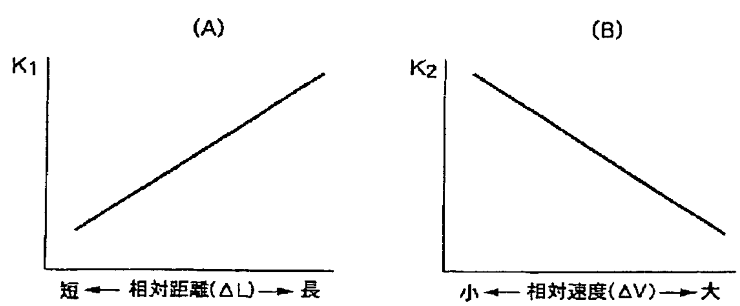
【図８】



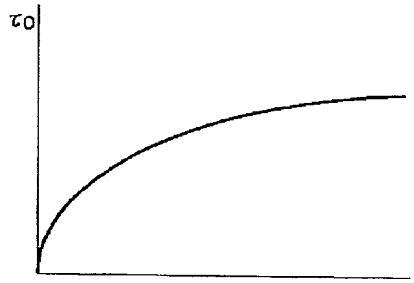
【図９】



【図１０】



【図１１】



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